METHOD OF MANUFACTURING ENHANCED TEETH OF DIPPER BUCKET OF SHOVEL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the manufacturing of dipper bucket of shovel and more particularly to a method of manufacturing teeth of a dipper bucket of shovel with improved characteristics such as strengthened structure and improved ductility.

2. Description of Related Art

A conventional dipper bucket 1 of shovel is shown in FIG. 1. Conventionally, the dipper bucket 1 is susceptible of damage due to frequent use. Particularly, teeth 101 of the dipper bucket 1 are susceptible of damage because the teeth 101 are frequently inserted into, for example, earth for lifting and removing the same. Unfortunately, the dipper bucket 1 has to be replaced with a new one once the teeth 101 are damaged. This is because the teeth 101 are integrally formed with the dipper bucket 1.

Another conventional dipper bucket 1 of shovel is shown in FIG. 2. The dipper bucket 1, as an improvement of the one shown in FIG. 1, has a plurality of detachable teeth 101. As such, there is no need to replace the dipper bucket 1 once the teeth 101 are damaged. In other words, a simple

replacement of the damaged tooth 101 with a new one is sufficient. However, both prior art dipper buckets suffered from a disadvantage as illustrated in FIG. 3. For example, a load of the dipper bucket per shovel is only about 80% of the volume of the dipper bucket (see lower portion of the right dipper bucket). This is because depth of the teeth inserted into earth is relatively short. An increase of length of the teeth is proposed to eliminate the above disadvantage. However, elongated teeth tend to break due to insufficient structural strength. Hence, a need for improvement exists.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a process of manufacturing a tooth of a dipper bucket of a shovel, the tooth having a larger joining portion coupled to the dipper bucket and a sharp portion, the process comprising cooling the molded tooth in a furnace at about 920℃, suddenly cooling the tooth in a fluid contained in the furnace, heating the tooth at about 460℃, slowly cooling the tooth in the air, supporting the tooth in the furnace with the joining portion immersed in the fluid and the sharp portion exposed in the air, and producing the finished tooth. The present invention has the advantages that the teeth are less brittle and more ductile while having a sufficient hardness, the teeth can dig further into earth for increasing load of the

dipper bucket per shovel, and the teeth are durable.

The above and other objects, features and advantages of the present invention will become apparent from the following detailed description taken with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a conventional dipper bucket of shovel;

FIG. 2 is a perspective view of another conventional dipper bucket of shovel with the teeth detached;

FIG. 3 is a side plan view illustrating a load of the dipper bucket per shovel of either prior art;

FIG. 4 is a side plan view of a preferred embodiment of dipper bucket having teeth manufactured according to the invention;

FIG. 5 is a flowchart illustrating a process of manufacturing a tooth of dipper bucket of shovel according to the invention;

FIG. 6 is a cross-sectional view of an electric furnace of the invention with the tooth immersed in hot fluid of the furnace;

FIG. 7 is a side plan view of the tooth of the invention for illustrating hardness distribution in different portions thereof;

FIG. 8 is a side plan view illustrating a load of the dipper

bucket per shovel of the invention; and

FIGS. 9A and 9B are side plan views of the teeth of the invention and the prior art respectively for comparing hardness distribution in different portions thereof.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 4, a tooth 10 of dipper bucket 2 of a shovel to be manufactured by the invention is shown. The dipper bucket 2 is threadably secured to an arm 1. Also, the tooth 10 comprises a larger joining portion 11 coupled to the dipper bucket 2 and a sharp portion 12.

Referring to FIG. 5 in conjunction with FIGS. 6, 7 and 8, a process of manufacturing the teeth 10 of the dipper bucket 2 in accordance with the invention is illustrated. Steps of the process will now be described in detail below. In step A (quenching step), cool the molded tooth 10 in an electric furnace 30 at temperature about 920℃ for increasing its hardness. In step B (first cooling step), suddenly cool the tooth 10 in an oily fluid. In step C (first annealing step), heat the tooth 10 at temperature about 460℃ and then cool slowly to prevent brittleness. In step D (second cooling step), slowly cool the tooth 10 in the air. In step E (second annealing step), a support 20 at the bottom of the furnace 30 is provided for supporting the tooth 10 in which the larger

joining portion 11 of the tooth 10 is immersed in the hot fluid contained in the furnace 30 and the sharp portion 12 thereof is exposed in the air.

Note that heating elements of the furnace 30 are provided in the bottom thereof. Hence, temperatures in different portions of the furnace 30 may be different. As shown in FIG. 6 specifically, higher temperature is measured in the bottom of the furnace 30 while lower temperature is measured in the upper portion thereof. In other words, temperature drops from the bottom of the furnace 30 to the upper portion thereof. For example, the highest temperature 560℃ is measured at fluid in the bottom of the furnace 30 and temperature 460℃ is measured at the surface of the fluid in the furnace 30. Eventually, in step F a finished product is obtained. As shown in FIG. 7 specifically, hardness distribution in different portions of the tooth 10 is shown. As shown in hardness distribution in the joining portion 11, the larger root portion of the joining portion 11 has a smaller hardness (e.g., hardness number is ranged from about 35 to 36 as expressed by 35 HRC to 36 HRC (which means Rockwell hardness number) while the tapered portion thereof has a larger hardness (e.g., hardness number is ranged from about 45 to 46 as expressed by 45 HRC to 46 HRC).

The joining portion 11 has a strengthened structure and

improved ductility. Hence, it is possible of increasing length of the integral sharp portion 12 without worrying about breakage thereof while inserting into earth in operation. As a result, a load of the dipper bucket 2 per shovel is increased (see FIG. 8).

Referring to FIGS. 9A and 9B, comparison of hardness distributions of the tooth of the invention (e.g., HRC is ranged from 46 to 48 at the sharp portion 12 and HRC is ranged from 35 to 46 at the joining portion 11) with that of the prior art (e.g., HRC is ranged from 46 to 48) is illustrated. In brief, the tooth of the invention is less brittle as compared with that of the prior art. Hence, the teeth of the dipper bucket of the invention can dig further into earth for increasing load of the dipper bucket per shovel. Most importantly, the teeth of the invention are durable.

While the invention herein disclosed has been described by means of specific embodiments, numerous modifications and variations could be made thereto by those skilled in the art without departing from the scope and spirit of the invention set forth in the claims.